Research Article

Assessing Intake of Probiotic Foods in the Form of Fermented Foods and Supplements

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ABSTRACT

Introduction and Aim: Probiotics are healthy bacteria that support gut health. They are also found in fermented foods and dietary supplements. This study examined the awareness and use of probiotics among adults.

Materials and Methods: The survey was conducted using an online questionnaire with 802 respondents on World Digestive Health Day. The questionnaire collected data on probiotic consumption, awareness, and demographics. Complete Responses from 800 people were analyzed using chi-squared tests to compare the associations between sex, age, and regional differences in probiotic awareness and use.

Results: Among the 800 respondents (621 women and 179 men), 82% were aware of probiotics. No significant gender differences were observed in the informed group; however, men were significantly more likely to be in the uninformed group. Awareness was most common among those aged < 40 years (68%), with a marginally significant age difference. Probiotic supplement intake was low (9.75%), with a higher weekly intake reported by women. The regional variation in intake (North India vs. South India) was not significant.

Conclusion: Probiotic awareness is relatively high, particularly among younger adults and women; however, supplement use remains limited across all demographics.

Keywords: Probiotic, Supplements, Fermented food

1. INTRODUCTION

1.1 Role of microbes in probiotics

Beneficial microorganisms, known as probiotics, comprise living bacteria that contribute positively to overall well-being, particularly digestive health. These microbes are naturally present in the human body; however, stress, poor diet, illness, and antibiotic use can upset the equilibrium of the gut flora. Probiotics, found naturally in our bodies, can be disrupted by stress, inadequate nutrition, illness, or antibiotic use, leading to an imbalance in the gut ecosystem. This imbalance can manifest as digestive problems, weakened immunity, and other health complications. Probiotics replenish and restore the equilibrium of healthy bacteria in the stomach [1]. The term "probiotic" originated in 1965 from Latin, translating to 'for life'. For centuries, fermented foods such as yogurt, beer, bread, wine, kefir, kumis, and cheese were commonly employed for therapeutic purposes before the identification of microorganisms [2]. The term "probiotic" was first used in the 20th century. Elie Metchnikoff, Russian French zoologist, is often referred to as the "Father of Probiotics" for popularizing the concept of probiotics as we understand it today [1, 3]. The most frequently used probiotics are bacteria, primarily strains from the *Lactobacillus* and *Bifidobacterium* families [4].

Probiotics in dietary supplements and medicinal products

Probiotics can also be found in dietary supplements, such as capsules, tablets, and powders. When ingested, probiotics facilitate digestion and nutrient absorption and contribute to the production of vitamins, such as vitamin K

and certain B vitamins. Furthermore, probiotics can enhance the immune system by controlling the growth of harmful bacteria, stimulating antibody production, and activating immune cell function. Research suggests that probiotics may offer a range of health benefits, including alleviating the symptoms of digestive disorders such as irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), and diarrhoea. They may also help alleviate bloating, gas, and constipation. Additionally, probiotics have been shown to strengthen the immune system and reduce the risk of respiratory infections, allergies, and certain autoimmune diseases. Probiotics are beneficial bacteria that confer health benefits to the host when administered in adequate amounts. In contrast, prebiotics are non-digestible fibres that serve as food for beneficial bacteria in the gut, helping them grow and thrive. Inulin and fructo-oligosaccharides (FOS) are examples of prebiotic fibres [5].

1.2 Global probiotics market and usage trends

As of 2022, the global probiotics market was estimated to be worth USD 77.12 billion. In Asia and Europe, probiotics are commonly consumed as dietary supplements and as medicinal products. The European market is leading the global probiotic market in terms of size and growth rate, with an annual increase of approximately 20% [6]. Dairy-based probiotics hold a major share in this segment, followed by fruit-based probiotic drinks [7].

1.3 Fermented foods and yogurt as probiotic sources

Yogurt is a fermented dairy product rich in nutrients and minerals that is widely used as a probiotic in food intake. Its consumption has increased globally because of its nutritional value and ease of digestion. Yogurt can be fortified with various bioactive compounds to improve health. This includes strengthening the immune system and alleviating allergy symptoms. Probiotics and natural additives are combined in yogurt to enhance its safety and nutritional value. Examples of these added components include natural plant extracts and bioactive peptides [8-10].

1.4 Guidelines and quality control of probiotics

Several organizations have thoroughly examined existing research and created guidelines for utilizing particular probiotics, encompassing suitable products, dosage, and composition, to either prevent or manage a range of health issues [11, 12]. The number of active cells in a probiotic product is measured in Colony-Forming Units (CFU). Typical CFU counts in probiotics range from 1 billion to 10 billion per serving; however, some products have much higher counts. A higher CFU count does not indicate better efficacy, and other factors, such as product quality and individual response, should also be considered [13, 14]. Global and non-governmental regulatory bodies (WHO/FAO) oversee the quality control and compliance of probiotic products, stressing the importance of standardized and precise quality monitoring to maintain the highest standards and guarantee the viability and accurate identification of the contained strains [15].

By addressing these challenges and considerations, researchers and healthcare professionals can develop more effective strategies for assessing probiotic intake and optimizing the use of probiotic foods and supplements. This study aimed to assess the consumption of probiotic-rich foods, including fermented products and dietary supplements, by the participants.

2. Materials and Methods

In commemoration of World Digestive Health Day on May 27, 2020, a survey was initiated to measure awareness of digestive health and probiotics among adults. The online survey was accessible to volunteers who wanted to participate in the study. The main objective was to collect information regarding the consumption of probiotics, particularly in the form of fermented foods and supplements, as part of the daily diet of adults. The survey was meticulously designed, including a mix of questions to measure the consumption of probiotics in food items such as idli, dosa, dhokla, curd, yogurt, sauerkraut, kimchi, and tempeh, and probiotic supplements. The questionnaire aimed to collect

detailed data on dietary intake and awareness of probiotics. The survey data were systematically structured and analyzed statistically. The survey was brief, and participants completed it in minutes. A total of 802 volunteers participated in the study, 90% of whom were Indian, with the remaining 10% from other nations, such as the UK, UAE, and USA. In the analysis, the hypothesized values assumed no correlation between sex and knowledge of probiotics, representing the expected proportions for both groups. The expected counts were calculated by multiplying the total within each category by the proportion. The chi-squared test was applied to measure the observed expected values, and the contribution of each count was calculated. This helps determine whether the differences between the observed and expected values are statistically significant.

3. Results

The survey involved 802 respondents, of whom two were excluded due to incomplete responses. Probiotic awareness by gender, as seen in Table 1, revealed 118 males and 539 females among those who said they knew about it, against the expected counts of 131.4 and 525.6, respectively. The chi-square test for females resulted in a statistic of 0.34 and a p-value of 0.55, with no significant gender difference in probiotic awareness. Among the respondents, 69 men and 74 women had no probiotic awareness and were expected to have counts of 57.2 and 85.8, respectively. The chi-square test showed a significant difference between the genders (χ^2 = 4.06, P = 0.04). As indicated by the gender distribution, most of the participants were female (n = 621), and the number of male participants was 179 (Figure 1).

Table 1. Statistical analysis of probiotic awareness with gender difference

Probiotic awareness	Category	Hypothesized	Observed	Expected	Chi-Square Statistic	p value
Yes	Male	0.2	118	131.4	1.37	0.19
	Female	0.8	539	525.6	0.34	
	Total	**1**	**657**	**657**	**1.71**	
No	Male	0.4	69	57.2	2.43	0.04
	Female	0.6	74	85.8	1.62	
	Total	**1**	**143**	**143**	**4.06**	

Note: Data from two respondents were excluded from the table because of incomplete responses.

These findings indicate that, although probiotic knowledge did not vary significantly by gender among those knowledgeable, there was a statistically significant gender difference among those unaware of probiotics.

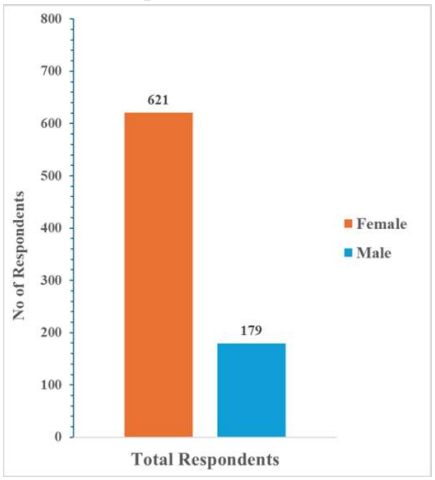

Figure1. Awareness of term Probiotic and awareness of Probiotic in gender difference

Figure 2 shows the distribution of probiotic awareness by age group among the 800 respondents who participated in the study. The largest number of respondents who reported awareness of probiotics was below 40 years of age (n = 543). This was followed by 202 subjects between 40 and 60 years of age, and 55 subjects aged > 60 years. These results revealed the highest probiotic awareness in the young population, which decreased with age, indicating a possible age-related variation in knowledge or exposure to probiotics.

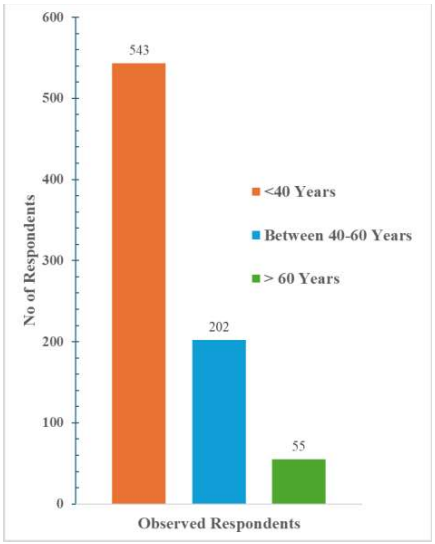

Figure 2. Awareness of Probiotic: Age difference

The hypothesis was that 70% of the respondents would be less than 40 years old, 25% would be 40–60 years old, and 5% would be more than 60 years old. The observed frequencies were 543 for individuals under 40 years, 202 for individuals aged 40–60 years, and 55 for individuals over 60 years, against the expected values of 560, 200, and 40, respectively, respectively. The chi-squared test produced a total statistic of 6.16 with a p-value of 0.05, showing a marginally significant difference in probiotic intake according to age group. The largest chi-square contribution was from the >60 years age group ($\chi^2 = 5.63$), indicating that people older than 60 years were more likely to use probiotics than expected. This indicates a possible age-related difference in probiotic usage behaviour (Table 2).

Table 2. Probiotic consumption among age difference

Age	Hypothesized	Observed	Expected	Chi-square Statistic	P-value
< 40	0.7	543	560	0.52	0.05
40-60	0.25	202	200	0.02	
> 60	0.05	55	40	5.63	
Total	1	800	800	6.16	

Note: Data from two respondents were excluded from the table because of incomplete responses.

The consumption of probiotic supplements, based on the consumption reported by the respondents, is presented in Figure 3.

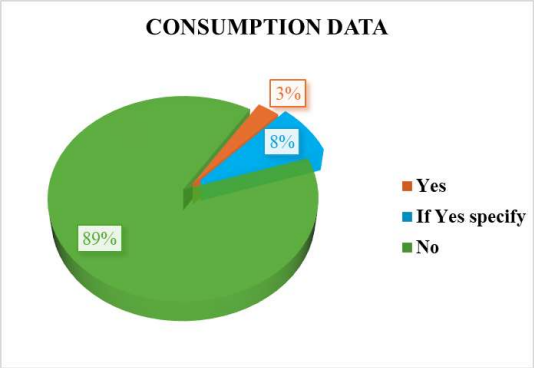

Figure 3. Consumption Probiotic supplements among the respondents

According to the results, 11% of the participants reported consuming probiotic supplements. Of these, 8% provided specific information about the type or form of the supplements consumed. In contrast, 89% of respondents reported not consuming probiotic supplements. These results indicate a low level of probiotic supplement use among the study population, implying limited adoption or knowledge of probiotic supplement use despite widespread awareness of probiotics.

Among the women, 73 reported consuming probiotic supplements on a weekly basis, while 548 did not. In comparison, only five males reported weekly consumption, with 174 indicating no weekly consumption. Overall, 78 respondents (9.75%) reported weekly consumption, whereas 722 (90.25%) did not. These results highlight that the consumption of probiotic supplements on a weekly basis was generally low in both sexes, with a higher frequency observed among females than males (Figure 4).

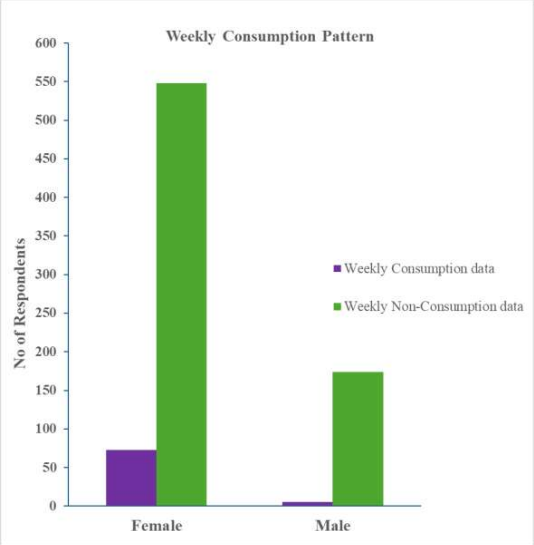

Figure 4. Weekly and non-weekly consumption of probiotic supplements among male and females

Table 3 presents the analysis of probiotic use in terms of regional variation among the 800 respondents. We hypothesized that 25% of probiotic use would be from the north and 75% from the south. Frequencies of 189 and 611 were observed, compared with the expected frequencies of 200 and 600, respectively.

Table 3. Consumption of probiotic among regional difference

Region	Hypothesized	Observed	Expected	Chi-Square Statistic	P-value
North	0.25	189	200	0.61	0.37
South	0.75	611	600	0.2	
Total	1	800	800	0.81	

Note: Data from two respondents were excluded from the table because of incomplete responses.

The chi-square test revealed an aggregate statistic of 0.81 with a p-value of 0.37, indicating no statistically significant difference in probiotic intake between regions. These findings indicate

that probiotic intake was fairly evenly spread across regions according to the hypothesized proportions.

4. Discussion

The present study evaluated probiotic food intake in the form of fermented foods and supplements in a mixed sample of 800 participants after excluding two incomplete responses from the analysis. Our analysis focused on demographic factors such as age, sex, and region, as these variables are widely recognized to play significant roles in health awareness, health-seeking behaviours, and dietary patterns. Our findings, which show differences in probiotic awareness and use across these groups, are consistent with this understanding. Gender analysis revealed that, although there was no statistically significant gender difference in probiotic awareness among those who were aware ($P = 0.19$), there was a gender difference in those who were unaware of probiotics ($P = 0.04$), with male respondents being more likely to lack awareness. This is consistent in part with research by Ailioaie and Litscher, which indicated that health-related behaviours, such as the use of dietary supplements, were found to be higher among women [3]. Likewise, Urbas *et al.,* (2024) indicated that women tend to be healthier in general, and that may contribute to their enhanced probiotic awareness [4].

Awareness by age was the highest among individuals below 40 years of age and declined with increasing age. This is in agreement with Myers, who reported that younger people, particularly students and professionals, were more frequently exposed to health trends and nutrition innovations, such as probiotics [16]. Interestingly, awareness decreased with increasing age among those aged ≥ 60 years, yet consumption was marginally higher among the >60 group than predicted, indicating that older people, once aware of probiotics, would be more likely to take probiotics because of health issues. Abdelhamid *et al.,* (2023) also noted this trend, with reporting of heightened probiotic use among older adults for gastrointestinal health management. In contrast to the relatively high levels of awareness, the genuine consumption of probiotic supplements in the current study was surprisingly low, with only 3% reporting use, and only 8% of those users reported the form or type [8]. This wide awareness-consumption gap aligns with the results of Swanson *et al.,* (2020), who stressed that despite probiotic products being largely known, misunderstandings about their health benefits, correct usage, and formats largely lead to low consumption by consumers [15]. Das *et al.,* (2023) identified the same difference in their review of traditional Indian fermented foods, whereby knowledge did not automatically translate into frequent consumption [10].

Weekly consumption variations by sex revealed that 73 women and five men consistently consumed probiotic supplements. While this supports the gender-specific health behaviour discrepancy cited by Ozen and Dinleyici, it also identifies a probable target for directed education and marketing, particularly among male consumers [2]. The low overall weekly frequency of consumption (9.75%) validates Merenstein *et al.'s* (2020) observation of the underutilization of probiotics in situations where their health effects are appreciated [11]. The regional difference study did not indicate any significant variation in probiotic intake between the North and South, defying conventional expectations that eating habits vary widely by region within India. This could be an indicator of the growing homogenization of eating habits with globalization and exposure to the digital world, as affirmed by Ilango and Antony, who stated that food items rich in probiotics are increasingly becoming universally available through both conventional diets and commercial foods [7]. The low rate of probiotic supplement uptake, given the high levels of awareness, could also indicate a lack of understanding of what makes a good probiotic product. Gibson *et al.,* (2017) and subsequently Swanson *et al.,* (2020) highlighted the importance of improved labelling and education on probiotic strains, dosages, and health benefits to address the awareness-consumption gap [5, 15]. According to a Grand View Research report, consumer education lags behind the expansion of the global probiotic market, especially in the developing world [16].

In addition to raising awareness and improving labelling, it is important to emphasize that probiotic intake should be considered alongside holistic lifestyle changes such as maintaining a balanced diet, regular physical activity, stress management, and adequate sleep, since gut microbiota composition is strongly influenced by these factors [17, 18]. Overreliance on supplements without supportive dietary patterns, such as high fiber and prebiotic intake, may limit the benefits of probiotics [19]. Furthermore, individual variability, including pre-existing health conditions, antibiotic use, and genetic predisposition, should be considered before recommending probiotic supplementation [20]. These considerations underscore the importance of integrating probiotics into a broader lifestyle modification approach rather than viewing them as a stand-alone health solution. The administration of probiotics in children has shown potential benefits, such as reducing the risk and duration of acute infectious diarrhea, preventing antibiotic-associated diarrhea, lowering the incidence of atopic dermatitis, and supporting immune system development [21, 22]. These findings highlight that probiotics may play an essential role in pediatric health promotion beyond adult health awareness, making early life interventions a potential avenue for bridging the awareness–consumption gap.

One major limitation of this study is its use of self-reported data, which are susceptible to recall or social desirability bias. The fact that the survey was conducted online may have excluded less technologically proficient people, narrowing the applicability of the results. The study did not differentiate between the use of different types of probiotics in various foods, nor did it examine their specific health outcomes among volunteers, which restricts the depth of insight into strain-specific or product-specific effects. Another limitation is the unequal gender distribution of participants, with more females than males, which may have influenced the findings related to awareness and consumption patterns.

5. Conclusion

The present survey, which aimed to measure the awareness and use of probiotics among adults, showed major findings based on sex, age, and geographical differences. Although awareness among the participants in this study was generally high, especially among younger women, the actual use of probiotics, particularly as supplements, was low. More extensive public health education is required to clarify the functional benefits of probiotics, particularly in older populations and male groups with lower awareness or participation. These results affirm the increasing body of literature highlighting the need to incorporate probiotics into mainstream health promotion activities for improved public health outcomes.

Acknowledgement

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Conflict of Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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Ethical Information

This study collected data through a survey. Participation was voluntary, and informed consent was obtained from all respondents before their participation. This study ensured the anonymity and confidentiality of the participants' responses.

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